[COMMITTEE PRINT]

HIGHWAY TRANSPORTATION INFRASTRUCTURE RESEARCH AND TECHNOLOGY

REPORT

PREPARED BY THE

SUBCOMMITTEE ON
INVESTIGATIONS AND OVERSIGHT

AND THE

SUBCOMMITTEE ON
TRANSPORTATION, AVIATION AND MATERIALS

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LETTER OF SUBMITTAL

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND TECHNOLOGY,
Washington, D.C., May 1984.

Hon. DON FUQUA,
Chairman, Committee on Science and Technology,
U.S. House of Representatives

DEAR MR. CHAIRMAN: We are pleased to transmit the joint report of the Subcommittee on Investigations and Oversight and the Subcommittee on Transportation, Aviation and Materials entitled, "Highway Transportation Infrastructure Research and Technology." The report presents the findings and recommendations from our joint hearings on transportation infrastructure research and technology held on June 9, 15, and 16, 1983.

The Subcommittees, in conducting joint hearings on highway transportation infrastructure research and technology, were particularly interested in assessing the use of improved technologies, materials, and construction methods to ensure that highway funds are used in the most cost-effective manner possible. The Subcommittees also sought to assess whether the scope, organization, direction, effectiveness, and funding of current research in highway transportation is adequate to meet the challenges of the new highway investment programs to economically and effectively rebuild the Nation's highway transportation infrastructure.

We note with special appreciation the expert assistance of Leon M. Cole, Chief of the Economics Division of the Congressional Research Service at the Library of Congress. The efforts of Dr. Cole to organize and focus the hearings and to help prepare this report contributed greatly to our success.

Sincerely,

ALBERT GORE, JR.,
Chairman, Subcommittee on Investigations and Oversight.
DAN GLICKMAN,
Chairman, Subcommittee on Transportation, Aviation and Materials.

I. INTRODUCTION

On June 9, 15, and 16, 1983, the Subcommittee on Investigations and Oversight and the Subcommittee on Transportation, Aviation, and Materials held joint hearings on highway transportation infrastructure research and technology. The hearings were prompted by concerns that the Nation's infrastructure, notably its highways and bridges, are deteriorating and are in need of major repair or replacement. Since large expenditures of public funds will be necessary to undertake these tasks, the Subcommittees sought to examine the state of the research effort and the technological development that will support the necessary repair and reconstruction. The specific purposes of the hearings were to assess the current status of highway transportation infrastructure research activities and funding; to explore effective ways to enhance national priorities for on-going transportation infrastructure research programs; to examine ways to promote research progress; to encourage applications of research findings, and to achieve timely results from research efforts.

At the initial hearing officers of national research institutions in the United States were invited to discuss highway infrastructure research problems and needs. In addition, Secretaries of Transportation from four states provided perspectives on state highway transportation infrastructure research. At the second hearing, testimony was presented by senior private-sector corporation executives responsible for research and development; academic experts involved in highway and materials research; and representatives from the Portland cement and asphalt manufacturing industries. The Subcommittees also received testimony from the President's Office of Science and Technology Policy and from the U.S. Department of Transportation on the third and last day of the hearings.

II. BACKGROUND

The highways and bridges of the Nation, essential fixed capital components of the economy along with other infrastructure systems, are deteriorating at an alarming rate in recent years. Programmatic attention and funding for repair and rehabilitation have generally not kept pace with current transportation requirements.

The U.S. Department of Transportation estimates that nearly 10 percent of the Interstate Highway System (more than 4,000 miles) are in need of immediate or near-term resurfacing or replacement. Beyond the interstate system, 50 percent of the entire primary highway system will reach the end of its design life during this decade. Moreover, 23 percent of the Nation's bridges have been identified as structurally deficient.

Our Nation is now beginning major new investments in highway transportation infrastructure to repair and improve our highway systems. Considering both the importance of our Nation's highways to commerce and industry, and the exceedingly large estimates of repair and replacement costs, the need for and importance of well-directed and targeted research efforts to support these substantial investments is clear.

In December, 1982, Congress enacted the Surface Transportation Assistance Act of 1982 (Public Law 97–424), raising additional revenues to be used in part for highway and bridge repair and reconstruction. The importance of increased funding for resurfacing, restoration, rehabilitation, and reconstruction (the so-called 4R program) of highways and bridges was a perception widely shared in Congress, although sharp differences regarding the particulars of tax and program allocation proposals did exist and still remain. Despite the differences, the Surface Transportation Act was approved, and obligation ceilings totaling almost $53 billion for Federal-aid highway infrastructure construction, reconstruction, and preservation, along with safety programs, are set and extended through fiscal year 1986.

Increased Congressional attention to, and funding for, transportation infrastructure maintenance and preservation has not yet carried with it a concomitant interest re-directing and enhancing transportation infrastructure research programs. An overall evaluation of the highway infrastructure research effort could help to insure that limited research dollars are spent more effectively. The 1982 Act, as did previous acts, authorizes several special, ad hoc research studies, but the desirability of an enhanced, suitably funded, systematic program of basic research and technological development, to help insure that the increased transportation investment dollars are wisely spent, is a concept that has not yet received extensive legislative or executive branch attention.

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While research and development programs and projects have long been a part of the overall Federal-aid highway program, and while research is also an important element of the other mission of the U.S. Department of Transportation (DOT), DOT has acknowledged that transportation research and development has languished in recent years.[1]

The apparent disparity between the generally accepted need for increased attention to and efforts in transportation infrastructure preservation and the relative inattention to enhanced research to support such research led the Subcommittees to this investigation. The Subcommittees focused mainly on whether the overall public (and private) sector research and development efforts for transportation infrastructure, especially highways and bridges, are adequate—in funding, scope, organization, and direction—to support systematically and economically the anticipated large increase in future maintenance, rehabilitation, and reconstruction efforts.

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[1] U.S. Department of Transportation: Research and Development Policy Statement of the Department of Transportation, Washington, D.C., January 1981.

III. FINDINGS AND RECOMMENDATIONS

(1) Goals and Objectives

Finding: The Subcommittees find that the goals and objectives of existing transportation research programs are not well related to overall transportation system goals. There is little agreement or understanding of what the transportation system should be or what kind of society it should serve. Without clear goals, planners have been unable to adequately define the integrated set of research objectives necessary to support those goals. This has led to a fragmented approach to funding transportation infrastructure research largely directed at developing incremental solutions to current local problems which are often duplicative. There is currently no strategic, integrated long-range plan for R&D expenditures which could ensure that adequate funding is being focused on the critically important, large-scale problems.

Recommendation: The Subcommittees recommend that the Department of Transportation (DOT) submit to the Subcommittees and other appropriate committees of Congress by Oct. 1, 1984: (1) A comprehensive set of goals and objectives to meet future transportation infrastructure research needs of this nation. Objectives should be adequately described and justified on the basis of their relationship and contribution to the overall goals of the transportation system. (2) A long-range strategic plan for accomplishing these. The plan should identify specific research objectives with adequate specifications of the desired outcome, funding requirements and schedules.

(2) Condition of the Highway Infrastructure

Finding: The U.S. highway infrastructure is deteriorating at a more rapid rate in recent years. Nearly 10 percent (4,000 miles) of the Interstate Highway System is in need of immediate near-term resurfacing or replacement. Before 1995, an estimated 26,000 miles or 56 percent of the interstate highways will need major resurfacing or repair work. Beyond the interstate system, 50 percent of the primary highway system will reach the end of its design life during this decade. Bridges are in equal disrepair as 37 percent of the Nation's bridges are nearing the end of their 50-year design life, and 23 percent have already been identified as structurally deficient.

Recommendation: The Subcommittees recommend a renewed commitment to highway and bridge materials and structures research and development in order to provide for the most cost-effective expenditure of public funds for the rehabilitation and reconstruction of the Nation's highway infrastructure.

(3) Adequacy of Highway Infrastructure Research Funding

Finding: Support for highway research has declined significantly in the last 20 years. Research spending as a proportion of total highway spending is currently less than 0.15 percent, and is clearly not

adequate to support the substantial investment in the Nation's highway infrastructure.

Recommendation: The Subcommittees recommend that the Department of Transportation propose an increase in the proportion of currently available transportation funds for research in highway transportation infrastructure materials and technology to levels consistent with the critical importance of the highway system to the Nation's economic well-being. Appropriate mechanisms to be considered for achieving greater research funding should include, but not be limited to, (1) modifying the current 1½ percent formula for highway planning and research, and (2) negotiation of government-industry cost-shared programs for large-scale high-priority research.

(4) *Fragmentation of Research Efforts*

Findings: Current highway research programs emphasize small-scale projects, and are fragmented to the point where it is not possible to produce timely solutions to the complex technical problems of national application and importance.

Recommendation: The Subcommittees recommend that the Office of the Secretary of Transportation develop and implement a policy which would provide the institutional mechanisms for conducting large-scale research programs focused on major national priorities in highway infrastructure research and technology. Such policy should emphasize the consolidation of Federal, state and private sector funds for a more concerted attack on a smaller number of critical high-payoff research problems.

(5) *Key Priorities for Large-Scale Research Efforts*

Finding: Research programs to increase the quality and durability of a number of high-cost highway materials show the most promise for decreasing the cost of maintaining the highway infrastructure. For example: A 10 percent improvement in the average life of asphalt pavement would save $1 billion annually within a few years. Development of a noncorrosive de-ice would save much of the $6 billion annual expenditure for corrosion to bridge decks and vehicles. Research on new materials and the application of new materials such as fiberglass reinforced concrete likewise offer substantial savings to American taxpayers.

Recommendation: The Subcommittees recommend that the Department of Transportation develop and initiate a research program focused on increasing the quality and durability of high total cost highway and bridge materials. Such a program should include high-priority emphasis on increasing the life of asphalt and portland cement concrete pavements and the application of new materials for highway and bridge construction and rehabilitation.

(6) *Organizational and Operational Deficiencies in Research and Program Management*

Finding: Many of the current problems in highway infrastructure research programs seem to be the result of the low priority such programs have received at the Department of Transportation and Congress. There is no strategic plan which identifies goals and defines a set of integrated high-priority research objectives necessary to support these goals.

Recommendation: The Subcommittees recommend that the Department of Transportation prepare and submit to the Subcommittees and other appropriate Committees of Congress by October 1, 1984, a long-term strategic plan for highway infrastructure research and technology. Such plan should include a comprehensive set of goals and objectives by which new technologies could be used to decrease the cost of maintaining the highway infrastructure, and a long-range strategic plan of research and program management to accomplish these goals.

IV. SUMMARY OF TESTIMONY BY ISSUE

In organizing testimony of witnesses according to selected issues, statements are sometimes taken out of chronological order, separated, and rearranged. Sometimes unrelated portions of the testimony are deleted in order to reduce the length of the report and enhance clarity. Every effort has been made to preserve the accuracy of the testimony. Verbatim transcripts of all testimony of witnesses, and additional submissions for the record, of the three hearings on June 9, 15 and 16, 1983, are published separately in U.S. Congress, House; Committee on Science and Technology, Subcommittees on Investigations and Oversight and Transportation, Aviation and Materials: Transportation Infrastructure Research and Technology, Hearings, 98th Congress, 1st Session, (No. 22), June 9, 15, 16, 1983; Washington, U.S.G.P.O., 1983.

A. Condition of Highway Infrastructure and Current Needs

Congressman Dan Glickman, Chairman of the Subcommittee on Transportation, Aviation and Materials, opened the hearings with a statement of the subcommittees' concerns about the condition of the highway and bridge infrastructure and the government's current research programs in support of the highway infrastructure:

The highways and bridges of the United States, essential components of our nation's infrastructure and economic well-being are rapidly deteriorating. The typical interstate highway is designed to last twenty years before it requires major rehabilitation, and 41 percent of the interstate highway system has already reached this milestone. Forecasts indicate that by the year 1990, 75 percent of the interstate highway system will have reached the twenty-year milestone, while also being subjected to traffic at a level of 150 percent of the capacity these highways were designed to handle. Perhaps the most alarming example of the condition of our highway infrastructure is the fact that 23 percent of the nation's bridges have been identified as structurally deficient.

Although the recently enacted Surface Transportation Act will provide increased funding for highway and bridge rehabilitation, we must also renew our commitment to the research that supports that effort. This committee is particularly interested in assuring the use of improved technologies, materials, and construction methods to ensure that Federal highway funds are used in the most cost-effective manner possible.

We hope that these hearings will focus on what is and should be the Federal role in determining not only that we have pumped billions of dollars into our nation's highways and bridges throughout this country, but that we are also doing the appropriate amount of research so that those billions of dollars don't have to be replaced by additional billions of dollars five years down the line.

Congressman Albert Gore, Jr., Chairman of the Subcommittee on Investigations and Oversight, outlined the purposes of the hearings and expressed his interest in assuring that the current research effort is sufficient to protect the Nation's large investment in highway infrastructure:

Our nation is about to undertake a major new investment in infrastructure, and it only makes sense to look carefully at the research needs that should accompany that effort.

Considering both the importance of our nation's highways to commerce, industry, and recreational activities and the staggering estimates of repair and replacement cost—placed by some as a major part of the total cost of trillions of dollars—the need for and importance of a well-directed and targeted research effort becomes clear.

During our hearings, we will hear from academic, research directors, and business executives from state and local officials and from the Federal Department of Transportation. As we listen to these witnesses, we will seek to assess whether the scope, organization, direction, effectiveness and funding level of the current research effort is adequate to meet the challenge. We will be looking for suggestions to improve our current efforts, so that we can more economically and effectively rebuild.

Congressman Bill Carney, Ranking Minority Member of the Subcommittee on Transportation, Aviation and Materials, expressed the importance of an effective research program to assure that the money raised through increased fuel taxes is spent effectively:

It is clear that we have a difficult task ahead of us. How can we maintain the 3.9 million miles of streets and highways that we now have and continue to build more with the limited resources available? This is a challenge that we face.

The Surface Transportation Assistance Act of 1982 provides significant increases in funding for the transportation infrastructure. Over $55 billion in new money will be provided for the repair and improvement of our nation's highways and bridges and also for the capital investment in new ones. Fuel taxes will more than double to pay for this. We want to be sure that these dollars are spent effectively. It is always difficult to spend money on research when there is a pressing problem that needs immediate attention and certainly that is the problem that much of our highway infrastructure faces today. However, it should be clear that if we don't want another tax increase in the near future, we will have to find a better way to manage our transportation needs. We need to develop new technologies, new materials, and new methods of construction to b' 'ld the highways and bridges of the future.

Mr. John Kemp, Secretary of the Kansas Department of Transportation, reported that almost half of the Nation's bridges are structurally or functionally deficient, primary because of old age and the high cost of reconstruction:

Of our approximately little over half million bridges in the Nation, 45 percent are either structurally deficient or functionally deficient. I think that the important matter of that, even more important than the number, is that the number of deficient bridges is expected to increase in the future.

That is attributable to the fact in large part that 37 percent of the bridges were built in the period of 1940 and earlier. Kansas has 4.4 percent of the nation's bridges, but we have 5.9 percent of the nation's deficient bridges. The price tag on the bridges alone is about $47.6 million, and that is just really a drop in the infrastructure need bucket. The associated general contractors have estimated that it would take $3.03 trillion to save our backlog of infrastructure needs at this time.

About 60 percent of that is in the transportation area or $1.8 trillion dollars, and highways alone have $1.6 trillion of that figure, which is over half of the total.

Congressman Glickman inquired about the size of State highway infrastrucure problems in each of the States represented at the hearings, especially "the replacement or rehabilitation of existing structures, bridges, and roads," directing his questions to Patrick McHugh, Thomas D. Larson, John B. Kemp, and John Mladinov:

Mr. McHugh. There are two things to look at, and we keep hammering at the legislature, you have to look at structural integrity; secondly, operational integrity. Is it carrying the traffic it needs to carry?

We have both problems. We have the systems falling apart but we have systems that are relatively sound physically but they are jammed with traffic. They cannot carry it.

We are currently spending $1.5 billion a year thanks to the new Federal tax increase and our State tax increase and we think that will keep the system physically intact as it is today, in other words, it is not enough to make it any better, about a third of it is in real poor condition and it will stay that way permanently because as we fix it more gets worse.

So in Florida a billion-and-a-half keeps it intact. It doesn't begin to approach the operational problem. We have given up on that.

Mr. Larson. I think it is a disservice to try to put members on this figure because the number is so large as to be meaningless. When you talk about a trillion or trillion-and-a-half dollars, people's eyes just glaze over. I think it has to be in more specific kinds of terms and we try to talk in terms of specific bridges, specific roads and impacts in Pennsylvania. That is a more meaningful approach.

The highway community has done itself a disservice by putting out numbers that are simply incredible or at least nondiscernible to the public.

Mr. Glickman. Mr. McHugh, you talked about how much the State of Florida spends on an annual basis. What do you spend annually, Mr. Larson?

Mr. Larson. We have a $1.4 billion bridge bill that we promoted through our general assembly to fix 979 bridges. I can identify every one for our General Assembly members. That is specific. This summer we are spending $154 million on interstate highway restoration and I can show every mile where it will happen.

So that kind of specificity I think has to happen because people vote for improvements not for overall needs.

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Mr. KEMP. Our budget is about $400 million a year in Kansas and I would say, yes, we could calculate the needs and we would get you a large, large figure.

There is no way we will get all the needs. It is too big.

Mr. MLADINOV. We have cited a cost of what we say is necessary over the next ten years in order to hold our own but recognizing that our knowledge of what that local facility's position is and how it can be maintained is less than adequate. That number is $27 billion.

William J. Young summarized the reasons for the current condition of the Nation's highways and bridges. He indicated that the system has simply outlived its design life and been subjected to traffic levels and loads much greater than anticipated:

The reason our highways and bridges are in need of repair today is threefold: One, most of the interstate system has simply outlived its 20-year design life. That's as long as it was supposed to last. It was expected to need renovation after 20 years. Secondly, the traffic on many highways is three to four times greater than expected at the time the roads were built, and finally, the allowable vehicle weights have increased in the past two decades. This, of course, shortens the useful life of highways designed to carry lighter loads. The wonder is not that our highways are in need of rehabilitation, but that they are still performing as well as they are.

William J. Young discussed the reasons for the decline in research and development conducted by the cement industry, including an economy in recession, a decline in construction generally, an increase in capital demands, an increase in fuel costs, the procurement and contracting process, and others:

Our industry is just now beginning a slow recovery from several years of declining shipments and even more sharply declining profits. Cement use last year was at the lowest point in the past 20 years. Construction generally has declined as a share of the Gross National Product. It accounts for six percent of GNP today, compared to twice that much in 1950.

During the same time the cement markets were declining, the capital demands on our industry were tremendous. We had to respond to the OPEC prices by converting to coal as our principal fuel source. We had to adapt our plants to conform with the requirements of the Clean Air Act, and we had to replace high-cost plants with new technology.

Thus far I have alluded to the economic deterrents to higher levels of cement research. There are structural deterrents also.

For example, public construction contracts, traditionally, and often by law, are awarded to the low bidder. While this practice historically has been considered necessary to the public interest, the low-first-cost concept is a serious deterrent to new product development, quality improvement, and innovative technology. In construction, as in most activities, quality demands a premium.

Cement is, of course, a commodity, and every manufacturer makes essentially the same product. New developments, therefore, cannot be proprietary; they must be disclosed openly so that public agencies can

include them in product specifications which must be followed by all bidders. This is a further deterrent to materials research because the benefits of innovation are so hard for the innovator to capture.

Mr. Young cited and example of how research on steel reinforcement of concrete produced dramatic results by resulting in a savings of $100 for every one dollar of research money spent, and offered a number of recommendations on ways to improve current highway infrastructure research efforts:

Nearly all structural concrete contains steel reinforcement in some form. High-strength steel reinforcement was being used in buildings in the early Sixties, but there had not been any research to show that this steel would stand up under the moving loads on bridges. Until there was, it could not be used in bridge construction.

In 1971, the PCA and the Federal Government got together on a cost-sharing basis to develop the needed information. Now, as a result all reinforced concrete bridges can be built with high-strength steel at a 30 percent lower reinforcing cost. Translated into dollar savings, this means that taxpayers are saving at least $30–50 million every year on this one item. This represents a research payback of $100 in savings for every dollar originally invested.

Future research may offer even greater potential. For example, specialty cements now under development will make it possible to make pavement repairs or to place new overlays that can be back in service in 15 minutes and still provide a long service life. This means faster construction, lower maintenance, and a much lower annual cost for such highways.

Moreover, new materials like fiberglass reinforced concrete and modern high-strength concrete now being developed for bridges can drastically reduce costs and make bridges virtually maintenance free.

It is evident, then, that public agencies—and this means the taxpayers and highway users—can expect large dividends from more and better research in highway and bridge materials and construction. The question remains, how and by whom will this research be carried out.

One approach—and it is one I don't relish—is to rely on other nations for the needed research and technology, just as we have surrendered technical leadership in other industries. Or we can do what is necessary to put our nation back on track in this important area. We suggest the latter course is the only rational approach and we recommend the following four specific steps:

One. that public agencies, as agents for the American taxpayer, who really benefits from all this, increase their research participation with private industry on a cost-sharing basis.

Two, that more emphasis be placed on durability and quality of construction. This would create added incentive for materials producers to invest more in research and product development.

Three, that a larger share of present highway planning and research funds go into research. We understand that 1.5 percent of Federal highway expenditures are earmarked for HPR purposes—Highway Planning and Research—but that less than one-quarter of such funds go for materials-related research, with the remainder, the vast majority, allocated under the general heading of "planning."

Finally, that more expensive use be made of the research capabilities of private industry, such as our own research located in Skokie, Illinois, near Chicago.

Gentlemen, we have here a great opportunity to develop an efficient and productive partnership between government and industry.

Gerald S. Triplett outlined the status and trends in asphalt research, including areas such as materials, paving mixes, structural design, additives, and others:

Over 94 percent of all paved roads are surfaced with asphalt mixtures or treatments. This vast production and useage places an obligation and responsibility on the industry and the Institute to provide guidelines for the sound and economical use of the material.

The amount of research in asphalt pavement technology since the first asphalt pavement is voluminous. It can be separated in several areas: the development and improvements of materials, tests and specifications, compositional design of paving mixtures, and structural thickness design procedures.

In the area of materials, a variety of asphalt types were developed. Different additives, such as various elastomers and adhesion promoters, were evaluated and some are being used. A number of inorganic or mineral additives have been tried. Hydrated lime and flyash are some of the natural and industrial waste materials that have been evaluated and are routinely being used.

Mr. C. V. Wootan expressed his concerns about the current trend in research activities which emphasized applied research at the expense of basic research:

The American Association for the Advancement of Science, which performs periodic evaluations of the Federal R&D budgets, does not even list the Department of Transportation among the 11 Federal agencies that conduct basic research. Even by expanding the definition of basic research beyond the classic definition of "the search for knowledge for knowledge's sake" to a broader view that it is really "longer range research", or "strategic planning research", there is very little being done at any level in transportation.

From our own experiences, we have seen a definitive move in the other direction. More and more, the Federal program is being directed toward solving very specific problems and in getting those problems solved in the shortest time possible. As budgets get tighter, it apparently becomes more and more difficult to justify research programs that do not have a high probability of success and a rapid payoff. I think this is called "getting the biggest bang for the buck". Too often, however, I feel that this philosophy causes us to concentrate unduly on attacking those problems that are urgent rather than those that are important.

This is not to say that the applied programs are not needed. They address problems that definitely need solving. However, they should be only a part of a larger overall program that addresses the longer range issues as well. Had we had a longer range research program in place over the last 10 years, many of these urgent problems may have never arisen. And, until we do get one in place, we will probably continue in the reactive mode of addressing problems only after they arise and have become critical.

Research, both long range and applied, is needed now more than ever before, because our transportation system and the problems it faces is changing more rapidly than ever before. We are facing a growing population with greatly increased mobility demands. At the same time our roadway facilities are remaining relatively fixed and are aging, with many having already surpassed design life. As a consequence, we have both congestion and the need to maintain or rebuild old facilities while still keeping them in operation.

B. Adequacy of Funding for Highway Infrastructure Research

Thomas Deen indicated that highway research funding has declined in recent years. Research funding at the Federal level declined 38 percent from 1972 to 1980, and 40 percent at the state level:

The scale of highway research has been declining in recent years. This decline can be seen on this slide for the Federal level, which is a time series chart showing in constant dollars the total R&D funds in DOT which were a decline of about 38 percent in constant dollars, even though the entire program for the Department increased by 27 percent in this period.

The fifty states show a similar decline of about 40 percent in constant dollars in research spending over an eight-year period.

FHWA figures show that by 1979, only 15 percent of all planning and research funding, this HPR fund I described, was spent on research, 85 percent was spent on planning. This low research proportion appears to continue into the 1980s.

In summary, about $40 billion was spent by all levels of Government: state, local and Federal, on highways each year and only about $60 million plus or minus $5 million was spent on research or less than 0.15 percent. Our research spending as a proportion of total highway programs has declined for several years and since 1965 has dropped by 40 percent.

Congresswoman Claudine Schneider asked Mr. Deen and David R. Belle Isle, whether putting more money into high technology research is appropriate when "the solution may be more simple."

Mr. Deen. We can do anything with enough money. This call for research and the reason you go after research is to learn how to do these things more cheaply. Better materials would allow us to build a thinner pavement to carry a heavier load for a longer period. We can build a thicker pavement to do that now but it costs more. It is not a question of being able to do it, the question is the economics.

Dr. Belle Isle. I would like to respond as well. Congresswoman. My sense of the problem is not throwing more money at it either. I don't think the solution is to throw money at it. I think the solution is in the structures by which we do research and the strategy by which we do research.

For example, MIT has a materials science laboratory and in that lab they do research on various alternative materials. One of the materials is ceramics as potential application for highway construction. In that lab they have over the years moved away from government funding for research because that funding has never been consistent to allow critical mass research over a long period to really look at those materials.

They are using private sector money to the tune of 90 percent of their total funding to look at some of these ideas.

Mrs. SCHNEIDER. Well, both you and Mr. Deen stated that the research system is enormously fragmented and there needs to be a focus. I would hope that perhaps this committee could take some action in giving directions toward the appropriate body or bodies and insisting that we have some focus.

I, for one, am not at all inclined to vote for any budget that includes any money at all unless we know what we are going to get out of it, and we have a specific job description.

Thomas D. Larson commented on inadequacy of research funding:

The adequacy of research has been spoken to and clearly funding is inadequate. The small fraction of 1 percent is just not able to do justice to the subject even if you had ideal organization. Organization is a problem but funding is a problem as well.

John B. Kemp also expressed his concerns about research funding, indicating that it was less than 1 percent of the spending for transportation:

I think it is important to say that the private sector spends something like 2.3 percent of the Gross National Product on research where in the transportation area, we are at around two-tenths of one percent.

Congressman Glickman asked officials from the Department of Transportation about the low level highway research funding in comparison to air transportation research:

Mr. [Charles] Swinburn stated that more than half, about $300 million of the DOT R&D budget, was devoted to efforts to improve the safety and productivity of the nation's air traffic and air space system, of which this Subcommittee has been a very active participant and a catalyst in that effort. But in fiscal 1984, the FHWA will obligate $49 million for research in highway transportation, including infrastructure. and perhaps a total of $60 million will be spent in fiscal 1984 on all federally-assisted highway R&D programs.

Now, trucks carry 23 percent of all the revenue ton miles in freight traffic in the United States; air freight traffic in the U.S.-air freight amounts to 0.2 of a percent of the total. Not diminishing the significance of the air side of the picture, because the government has a historic and unique role in promoting air safety—that has been a unique Federal responsibility—but passenger miles by air amount to slightly more than 200 million each year, the public drives approximately 1.3 billion miles per year. Yet your 1984 R&D funding is five times higher for air space than it is for surface transportation.

So my question to you is shouldn't the percentage of dollars spent on roads by the Federal Government be shifted a bit to get more into the R&D side of the picture?

Charles Swinburn, Deputy Assistant Secretary for Policy and International affairs, Department of Transportation, agreed that spending for highway research and may not be adequate:

On the question as to whether we should be spending more money on R&D in the highway area, which is a very relevant question, particularly at this time when we're going through a major shift from new construction to preserving and rehabilitating our highway system, I am not afraid to admit, and I think you would find all of us not afraid to admit, that perhaps we should be spending more.

The FHWA, as Mr. Lamm laid out in his testimony, has been going through a great deal of analysis and research on that very question. We have asked the Transportation Research Board formally, at our suggestion and with our money, to look at what direction we should be taking in our highway R&D funding in the future. We are beginning to get results from that effort.

The FHWA has had a series of other efforts underway, consulting with the users of these funds, the States and local authorities, the people that actually do the work and from whence the money comes, and I think will be prepared very soon to lay out—and probably in the context of the fiscal year 1985 budget, although if it turns out we are able to reach conclusions with the TRB and the users before that, we would not be afraid to come back and ask for some reprogramming in the fiscal year 1984 budget—to address the question. It is a very valid question and we think you are asking it at the right time. The answer may well be yes, we should be spending more and we should be spending on some things differently or with greater emphasis than we are now spending it on.

Lester Lamm added comments about the lack of congressional support for highway research appropriations:

Mr. Chairman, let me just amplify that. I might mention that I have served as Executive Director and Deputy Administrator at the Federal Highway Administration for ten years this month. During that time, I have come to Congress with support information for ten annual budgets for the Federal Highway Administration. I must say, if this Committee comes in and tells the Federal Highway Administration we should be spending more on research, that would be a change from any Congressional advice we have had previously, because the appropriation committees, without fail, have cut our research proposals each year.

Congressman Glickman inquired about DOT intentions regarding the Transportation Research Board study on strategic transportation research:

Mr. LAMM. Our intent there is to use the transportation research community, both the private sector and other government levels, to give us advice and if the advice comes in saying that there should be a sizable increase in the amount of funding directed toward research, then, as Mr. Swinburn mentioned, we would certainly consider a reprogramming request as early as the fiscal year 1984 budget.

However, I should mention that the initial emphasis that Tom Deen's activity seems to be pointing out is that we can make a lot more productive use of our current research budget by consolidating the Federal, State and private sector funds in a more concerted attack on a smaller number of more productive problems. I think that is a very effective approach and we are certainly committed to working with TRB on that.

Mr. GLICKMAN. Right now, what would you think that consolidation would be focused on, what things would you be doing more of and what things would you be doing less of?

Mr. LAMM. In my statement, and I am sure in Mr. Deen's as well, we both reflect that we don't really know enough about the basic properties of asphalt. And while asphalt has been used as a roadbuilding material for many years, we may be even asking field engineers to make

the wrong tests on asphalt. It may not show the proper physical attributes that produce long-life pavements. It may well be that again we, at the Federal level, along with the State and private sector people, will refocus some of our research dollars and try and concentrate more effectively on that basic longer-term problem.

Congressman Glickman asked about the authority of the Department of Transportation to transfer funds to more critical areas of research:

Mr. GLICKMAN. On reprogramming, let's say you do come in, Mr. Swinburn or Mr. Lamm, and you have an internal feeling that you ought to be either reprogramming or redirecting more funds in certain areas. Under the Surface Transportation Act, do you have authority to move funds out of the construction side into the R&D side?

Mr. LAMM. No, sir, we do not. The shifts we would make would be within the contract research budget.

What we are saying is, if it turns out we take some of our previously anticipated funding and redirect it into a greater amount of attention toward the asphalt research area, we would need to notify the Appropriation Subcommittees of this. But we don't have the option of taking funds that are made available by formula to the States for construction and reconstruction and use those funds on research.

Congressman Glickman asked Douglas Pewitt about the declining level of Federal research in Transportation infrastructure:

Dr. PEWITT. One of the reasons that we have not concentrated in our office on transportation infrastructure problems in the main, is plain and simply the level of resources that the Federal Government has dedicated in this area has been relatively small compared to the rest of the $47 billion. As I said in my opening statement, we have not tracked transportation infrastructure very closely.

C. V. Wootan commented on transportation research funding needs, indicating that it had declined significantly in the last 14 years:

In 1970, transportation research was considered a relatively high priority item at the Federal level. It had the fourth highest funding level, exceeded only by defense, space, and health. In the 1983 budget, it has declined in importance to seventh place. It is now exceeded by Energy, the National Science Foundation, Agriculture and Interior. Transportation, which is directly responsible for over 20 percent of the nation's gross national product, is not receiving less than one percent of the nation's Federal R&D budget.

In absolute terms, the situation may be even more critical. During the decade of the Seventies, Federal transportation R&D was increased by only about 7½ percent. During this same period, the Consumer Price Index increased by 90 percent. In real terms, then, there was an effective decrease in transportation R&D activities amounting to over 42 percent.

At the Federal level, research in the transportation infrastructure is centered largely, if not exclusively, in the Federal Highway Administration. Its budget has generally tracked those of DOT as a whole, showing an absolute decline through the Seventies that has continued through 1983. Prior to the passage of the new gas tax bill, approximately one-quarter of one percent of the overall FHWA budget was devoted to R&D. It will probably be considerably less than that now.

The question then is, is this an adequate overall R&D effort to protect the national investment of well over a trillion dollars in capital improvements that we have made on our highway systems? Is it adequate to assure that we can continue to meet the mobility requirements of our expanding economy and growing population in the future? In my view, it is definitely not adequate by any measure one would care to apply. In fact, in previous discussions I have referred to it as being almost of criminal neglect in transportation R&D.

C. Fragmentation of Research Efforts: Lack of Optimum Scale of Effort

Thomas Deen indicated that the current decentralized process results in a system in which larger research problems cannot be effectively attacked:

Even though the current decentralized process I described is appropriate for our main efforts, the system nevertheless I think has some shortcomings. Perhaps the biggest of these is its apparent inability to focus large efforts on single problems however deserving they may be.

Most projects emerge in units of $150,000 to $400,000 and projects larger than a half million dollars are very rare. Yet some problems cannot be effectively attacked without mounting larger, more comprehensive efforts. While the vast majority of our research programs facing industry today can best be handled by this current and focused decentralized approach, there are a few areas where these are inadequate. One of the problems I cite is the asphalt pavement methods and materials which is an enormous industry, something like $10 billion a year will be spent for asphalt materials and we will reach that level, we are at 7 billion now.

It is a wonderful material, we are hooked on it and dependent on it. We would like it to have more durability, we would like if it would be more forgiving, not require such precision, it gives us an occasional embarrassing failure and we would like it to have a bit more endurance. We are not mounting a comprehensive effort to look at this kind of problem. We spend about $1 million a year in fragmented activities which is 1/100th of the total spending.

Responding to this problem requires more than increase in research funding although it is important. Equally important, would be a focus on the problem of bringing together the skills ranging from materials scientists and chemists on one end to highway and pavement specialists at the other end. Also required is a sustained level of effort in manpower, laboratory equipment, and facilities commensurate with potential payoff.

A 10 percent improvement in the average life of asphalt pavement would save us $1 billion annually within a few years. Spending 1 to 2 percent of that, $10 million to $20 million a year in a well-conceived program would not appear inappropriate although it is far in excess of our current efforts of about $1 million.

Asphalt is not alone. Portland cement, you can make an equally convincing statement about that. We have a number of studies that cite this fact. Other examples are use of salt for snow and ice removal, that is a cause of the large part of the $6 billion we spend for corrosion to vehicles, bridge decks and structures and environmental damage. Our

efforts to find a noncorrosive de-icer run half a million a year, and these are fragmented efforts.

David R. Belle Isle indicated that the President's Private Sector on Cost Control found that there appeared to be little direction and guidance from the Office of the Secretary of Transportation with regard to long-term research and development goals and strategy:

Currently within the Department of Transportation the R&D budgeting process is a bottoms-up within each operating mode process and that there is very little direction and guidance from the Office of the Secretary that encourages an integrated long-term strategy around R&D expenditures.

To the extent that you fragment R&D dollars, you are not able to achieve critical mass technology exploration and development. Our concern is that with the fragmentation of dollars and the spending levels at approximately $300 to $350 million annually, we are not seeing efforts that produce transportation innovation and productivity and technology advancements.

Congressman Gore summarized the comments of witnesses concerning fragmentation of research efforts, organization, and funding:

We need to spend more money on research, but even more importantly, we need to organize our research efforts better and identify serious problems which now plague the research effort.

Specifically, high management turnover is a problem; lack of continuity; and an inability to focus disparate elements to the research community on large questions that have a high priority for the country.

Am I right so far?

Mr. DEEN. Right.

Mr. BELLE ISLE. Very accurate.

Mr. BUTCHER. Yes.

D. PRIORITIES FOR LARGE-SCALE RESEARCH EFFORTS

Douglas Pewitt commented on the Reagan Administration's policy regarding highway infrastructure research:

The administration seeks to support sufficient basic and long-term nonproprietary applied research to improve our nation's science and technology enterprise. It recognizes the need for a strong Federal role in that support. The criterion of excellence, pertinence and appropriateness continue to be central to science and technology policy. Previous policies have failed in part to recognize these criteria and have distracted the Federal Government from its major responsibility and capability.

It is clear to us that we're going to make massive Federal investments in transportation. I have spent some time over the last seven months, even prior to these hearings, with the Department of Transportation, looking into their research capability. We have many questions. We don't have all the answers yet, but we have started to look into these areas. There is considerable research capability in the Department.

Congressman Glickman expressed the concern of the subcommittees and the key question of the hearings with regard to efficient expenditure of tax money:

The money, to not only repair potholes but to build roads, comes from a regressive tax. It comes out of the pockets of working people

who pay whatever the Federal and State gasoline taxes are. I would just think that you, as kind of the chief coordinating role for science issues within the administration, ought to ensure that you take an aggressive role in protecting the interests of those billions of dollars that are being spent to ensure, one, that the roads are adequately maintained and repaired, and two, that we do the research so that we can protect ourselves against deterioration.

Through more appropriate management of the existing system you can assure that we don't have to raise the gasoline taxes again in the future. R&D has to be a key part of that thing. How do you think your office can more effectively encourage Federal departments to support appropriate basic research, like in the transportation area, when Secretaries and Administrators seem only interested in short-term results?

Dr. PEWITT. We have emphasized materials research to a very significant degree, and we appreciate the support that the House Science and Technology Committee has provided to some of those initiatives in materials research because ultimately transportation infrastructure is a materials problem.

In the agencies that have significant basic research activities, we have emphasized basic research, as you know.

Mr. GLICKMAN. About 12 years ago Dr. David, who was President Nixon's science advisor, said that research into cement and highway construction materials was at the top of the list of areas in which the greatest return on the Federal R&D dollar could be expressed, but there have been virtualy no Federal R&D dollars to speak of that have been expended in that area. We are spending a lot on some of the more exotic materials, which I support as well, and it just looks like there's a gap that has developed there.

Congressman Gore emphasized the goal of the subcommittees: to save the taxpayers money through research, by doing more with less, during his questioning of Dr. Prewitt of the White House Office of Science and Technology:

Mr. GORE. We are on the verge of a massive new wave of public investment in the repairing and maintenance of this system. It is wearing out more quickly, for the reasons my co-Chairman stated in his opening remarks. We're going to spend tens of billions of the public's dollars on this new wave.

There are clearly opportunities to substitute thought for money. We can save lots of money if we can figure out how to do it a little bit better and extend the lifetime of these new improvements beyond what they would otherwise be.

Now, you and your colleagues at OSTP are concerned with the overall government research policies. We have heard testimony here about the tremendous opportunities to save money by doing research into concrete, cement, asphalt and all of that, all these things that are relatively mundane-sounding but have a tremendous potential to save the country money and to save the taxpayers money.

But the testimony has really been quite critical of the R&D policy of the administration. The statements submitted here today—and I will say this in a reserved and gentle way—the statements are a little flabby. They don't really respond direct to what I think has been a very extensive criticism from the private sector and university research community. I'm a little concerned about that.

Dr. PEWITT. I have given this some thought, among several other things that we have been concerned about. It appears to me that one asks how to build a highway, how to make that thing last. In fact, we know how to build a highway to last. The Romans know how to build a highway to last and they still operate pretty well. One builds based on some expectation for use. Perhaps we have used the techniques of cost-benefit analysis, systems analysis, and overlapped that, and we certainly underbuilt the interstate highway system. We underinvestigated. Those highways were not built to carry the loads. We tend in this society to cut things very closely when we're making capital investments.

Congressman Gore continued the questioning:

We had really interesting testimony yesterday from people organizing private research efforts, like the fellow from IBM, and he said when you're designing a new computer system some people have the all of the effort is focused on that; but he said a lot of times the real idea that you want to put all of your research into the microchip and all of the effort is focused on that; but he said a lot of times the real savings and the real improvements are going to come from research into that typewriter key hitting the paper and the ribbon. You have got to research improvements and identify opportunities to improve and make more productive all parts of the system. OSTP is making that mistake, in all due respect. We are really focusing on the exotic, high-energy physics areas, but when it comes to the tens of billions of dollars that we're going to ask the public to hike out in regressive taxes to fund continuously over and over and over again, we don't put any effort into research that will improve that task. We just sort of short-term and pave it over again. We're sort of "asphalt junkies" and we don't break that cycle and take the time and make the effort to improve that process, to break that relationship between investment and durability.

Dr. PEWITT. Well, a number of scientists have come by and talked to us about their clever ideas for how to address this infrastructure problem. It's not just highways and bridges. It's sewers and subways systems in our larger cities, too. And wishing something so does not make it so in the world of science is the problem. The question I always put to these people who have proposed these ideas to me is what is your specific program. We all recognize the problem. What is the approach that we should pursue? Until our office is presented—and I'm sure the Department of Transportation is looking at ways to do this. Until our office is presented with a plan with some efficacy to it by the agencies, we have very little basis in which to support an increase in a research program. We just simply have not seen it.

Mr. GORE. In other words, the ball's in DOT's court?

Dr. PEWITT. The ball is in the advocate's court to, in face, present something that has some technical efficacy.

Mr. GORE. You recognize the good sense of an effort to make our research effort more productive and try to cut down on this new wave of investment coming along, but the ball is in DOT's court to argue it with the Executive Office of the President and OSTP for an effective research program?

Dr. PEWITT. And we will support the Department of Transportation and other advocates in that arena if there is technical efficacy.

Charles Swinburn commented on DOT's Current Research and Development Policy, Structure and Programs:

In the highway area, the need to shift our emphasis from new construction to reconstruction was clearly spelled out in the Surface Transportation Assistance Act of 1982 and has clearly been mentioned by all of the witnesses and by yourself, Mr. Chairman, in the course of these hearings. Funds for repair in the Surface Transportation Assistance Act were significantly increased, and the Act included specific requirements for using a certain amount of this money on highway and bridge repairs. As a consequence of this Congressional direction, and the need to preserve existing transportation structures, future research emphasis will be principally on ways to make the existing system work better, more safely and economically, through both physical and operating improvements.

The nature of the Federal Government's involvement in research and development is a significant issue. In general, it is our belief that the Federal Government should not be so deeply and broadly involved in the details of making transportation decisions as it has been in the past. In most cases, State and local governments and the private sector are better situated to make these decisions.

In keeping with that belief, we are attempting to concentrate our R&D in areas, first, that have a recognized governmental mission, such as safety. Some of this type of R&D is present in all of our modal administrations.

Second, where R&D is clearly in the national interest and the investment won't be made privately. This is the case with much of our highway R&D.

Third, where there is direct government operating responsibility, such as in air traffic control.

And fourth, where the national security and emergency preparedness are involved.

The nature of the Department's R&D efforts are quite varied, since transportation encompasses a wide range of activities with vastly different requirements and a variety of users. Also, the organization of the Department strongly influence the character of the transportation R&D programs.

The Department's overall R&D budget requests for fiscal year 1984 are estimated to exceed $500 million, an increase of $126 million over fiscal year 1983 appropriations. More than half of this will support the Federal Aviation Administration's efforts to improve the safety and productivity of the national airspace system, including upgrading the air traffic control system.

Congressman Glickman questioned Patrick McHugh, Thomas D. Larson, John B. Kemp, and John Mladinov on research priorities from the perspective of the States:

Mr. McHugh. Well, our most pressing problem today is this question that you called diversion and other people addressed of the role of the other transportation modes. We know for sure as the other States have found that we cannot carry all our traffic on the highway system. We need some good information on the degree to which we can cause people to choose freely to move off the highway system to other modes. That is the real major problem in Florida today. The other is economical construction techniques and use of what is out

there. It is easy to talk about getting exotic materials to build roads but the fact of the matter is that the common materials like limestone and cement and asphalt are there and that is what we will probably use. What we need is research into the best ways of using what we have as opposed to finding something different that might eventually be better.

Mr. LARSON. First of all we need better institutional frameworks for accomplishing and using better technology. Second, we need to have our high cost items researched to the point of being able to make better life cost decisions. Then I guess the third one that I would mention would be probably in the area of trying to improve our construction techniques both in terms of lowering cost and lowering time. We are rebuilding and the Nation is rebuilding a lot of the old initiated highway systems where they now carry enormous volumes of traffic; and that they are finding ways to rebuild the facilities while the public is using them is something we have a long way to go on.

Mr. KEMP. I think pavement management certainly would have to come high on any list that we would have in Kansas because we spend such a big share of our total construction and investment dollar on pavement. We are developing a pavement management system but we are just kind of finding our way.

Certainly the management area is one that needs a lot of attention. How can we better use what we now have?

Mr. MLADINOV. As I said in my earlier statement, such a big proportion of our total budget is directed to maintenance. There should be increased research aimed at the maintenance area, improved materials, improved techniques, methodology. That is part and parcel of the management program as well. That is what pavement management is all about, to maximize the capability and at the least cost in keeping the facilities in operation.

Congressman Gore asked David R. Belle Isle and Thomas B. Deen their opinions on the top research priorities:

Mr. BELLE ISLE. I would say, Mr. Gore, long-range strategy, joint focus, continuity of that focus, clarifying the various roles for industry, government and universities in pursuing those areas, and being able to attract better talent and maintain them.

Mr. DEEN. Well, I have already mentioned the basic materials of asphalt and cement. I won't comment on that anymore. I think a noncorrosive device to help offset this enormous corrosion bill we pay every year is a big ticket item.

Mr. GORE. Something other than salt?

Mr. DEEN. There are some, yes. The problem is how we produce them cheaply enough, and there are ways they can be used that might well bring costs down.

I think the question of pavement management, about all we know of the question of how you design pavements and how much deterioration occurs from environmental factors versus heavy truckloads came from the several road tests done a number of years ago, and they have been repeated. They had certain deficiencies, but that is all we or the rest of the world know about it. There have been many recommendations to continue long-term studies of that type, and I would say that that would be a high priority item.

Gerald S. Triplett suggested promising areas for future research and a mechanism to establish priorities:

Very likely the major part of future funds and efforts will be expended for the improvement or for maintenance of existing pavements. Thus, research should be directed to rationalize and make these efforts more cost effective.

While procedures for overlaying such pavements are available, research to improve and verify the design methodology would be beneficial. The standardization for procedures for evaluation of existing pavements may also be beneficial. Construction methods, techniques, and equipment utilizing pavement overlays may be beneficial.

Della M. Roy summarized her views on national priorities for materials research:

As far as the summary, then, of the goals and mechanisms that I would see in the materials research area for application to highways, that in terms of national priorities one should shift the research priorities to science which is applied and purpose it. This is fundamental science. It must have a purpose and a direction. This requires a sustained, coordinated, targeted input from all our groups, from the university, from industry, from the government as the user, for reseach on low temperature—I call them low temperature ceramics, concrete, cement—low energy content materials which will be a part of the permanent future, but again, a sustained effort, not a short-term. It simply won't do if we are to do more than fill pot holes, but developing better materials that will prevent pot holes forming in the first place.

Possible mechanisms for doing this, there are a number but I just cited two or three examples here. Congressman Brown's bill, H.R. 481, to generate a National Technology Foundation would be one way to do this.

Another mechanism obviously is to earmark clearly part of the tax from the highway program for a coordinated research program. Now, I know this is the intention to do this, but to make sure it has that degree of coordination and sustained over some years. For really innovative things to happen, it requires the five- to 10-year time, not simply limiting it to what is needed for fixing the first bridge. In this, there should be the participation of the major universities, industries, in a network with the DOT or National Technology Foundation or coordinated by PCA, NBS and the relevant governmental bodies.

Congressman Gore questioned C. V. Wootan on what organizational and operational directions would be required for an enlarged Federal highway research program:

Dr. WOOTAN. To be certain, Mr. Chairman, I don't have solutions to all these problems. I think I can help identify some of the problems. We have the problem. I think, in terms of fragmentation of what small Federal research funding is available.

I think we have a problem of perception and salesmanship. It is much easier to sell a ten-year program of research and high energy physics because the general population sort of assumes it takes ten years to solve something in high energy physics, because they don't understand it. It is much more difficult to sell a ten-year program on fixing a pot hole or developing materials and processes that will allow you to repair potholes and keep potholes from appearing because the

general perception is you ought to know how to do that anyway. So we have a salesmanship problem within the DOT agencies themselves, where I think they feel they have to have high visibility, activities that they can demonstrate to the Congress, and that this is in a cyclical two-year type program, that they have to have benefits produced at least every two years in order to maintain their research programs.

So I would say we need to have a mechanism by which we can allow more innovative approaches to solving some of these problems, that will allow us to bring together greater interdisciplinary attacks to some of the major problems, including some of the policy-related problems that we are facing. This really doesn't fit too well with the procurement processes that the government uses, and I understand why those procurement processes are tight like that. But it is very difficult to issue procurements on a general base of doing a ten-year program in the area of research to come up with a generalized answer. It is much easier and much more defendable to say you will do one, two, three, four, five and you have something you can measure against—was it done or was it not.

So I think the procurement process is not well suited to it. We have a very small pie to begin with, that when you try to attack a whole bunch of problems it naturally fragments it. I think it is forcing us to work on those problems that appear to be more visible, more suitable to getting an answer back.

Congressman Gore questioned Dr. Roy on why cement and highway materials research had dropped from top priority in President Nixon's Administration:

I am fascinated by the testimony presented by this panel. Really, it is not only interesting, it is quite troubling because, taken together, your statements make up a powerful criticism of the R&D policies currently being followed. I must say, on the basis of other testimony we had, I have to agree with the thrust of your comments today.

Former President Nixon's research head had research into cement and highway materials as his top priority; is that right?

Dr. Roy. In one of his major policy statements he had emphasized this. As far as I could see, it fell pretty much on deaf ears and did not feed down into the structure that funds and coordinates research.

Mr. Gore. Why do you think it has fallen so far down the priority list, Dr. Roy? You say what this administration is doing won't be felt for 20 years, and then will be felt overseas before it is felt here. They have eliminated the Center for Building Research at the NBS and a number of other matters.

What do you think is the reason for that?

Dr. Roy. Cement and concrete, I suppose, because it is a basic structural material, there is a tendency on the part of many people to say it exists, it will perform, no matter what you do to it; whereas some of the more exotic materials have perhaps quicker payoff in terms of visible items that catch people's attention. So if one has a priority, it tends to go more towards the exotic materials, saying the others have performed and they will continue to perform, rather than making them better.

I think perhaps it is only now, when the attention again of the breakdown of things such as the highways, the immense need for repairs, can vividly call to the public's attention and it will filter back up.

E. Organizational and Operational Deficiencies in Research and Program Management

David R. Belle Isle summarized findings of the report of the Transportation Task Force of the President's Private Sector Survey on Cost Control:

On the whole much of the past R&D expenditures in the DOT are difficult to justify in terms of results. For example, some $750 million spent by UMTA for R&D has produced little change in the way people move about in American cities or contributed much in new productivity. That is not to say that development focused R&D is inappropriate to transportation. Technology innovation and productivity, however, DOT sponsored development projects are not producing useful significant advances. Our concern is that the quality of R&D suffers from inadequately specifying the desired outcomes and implementing programs to monitor and achieve them.

The second conclusion, research planning and coordination process requires change. The goal-setting process for R&D in the Department is not adequate. Given the primary focus on development R&D programs coordination was likely not to be perceived as valuable in the past.

However, there can be significant value coordinating long-term research in the Department.

In order to seize these opportunities, a coordination mechanism is called for. The Department of Transportation must take the lead to identify other significant technological needs and goals for transportation safety and then to coordinate the appropriate government, private sector and university resources to achieve them.

The third conclusion, research management and budgeting processes require change. Lack of a management system has detracted from development of long-term perspective and overall strategic purpose for R&D initiatives in DOT. Thus Congressional intent and DOT policies in support of it either have not been implemented or if implemented have not achieved their objective.

DOT can and should develop an R&D management and resource system to clarify strategic transportation goals and assure resources are appropriately targeted and controlled.

Four, research policy and organization issues must be addressed. Though Congressional statutes and DOT policies clearly encourage the private sector to invest in R&D programs to apply innovative technologies and to continue strong support for basic knowledge, research; there is limited evidence that these objectives are implemented or achieved.

The final note to make here is the DOT research organizations are too decentralized to achieve the value of coordinated research initiatives with other government agencies and nongovernment organizations.

Dr. Belle Isle continued with the Private Sector Survey on Cost Control Task Force recommendations:

The first recommendation is the Department of Transportation through the Office of the Secretary should create an entity responsible for R&D policy goal setting and monitoring. Specifically in this area

the overall DOT entity responsible for R&D policy should be created to accomplish the following: Define the goals and mission for DOT R&D and clarify the role that R&D must play; recommend to the Secretary policies and overall R&D goals and opportunities; serve as coordinator between various DOT R&D managers within the operating administrations and the Transportation Systems Center.

With this work arrangement, the strategic issues problems and opportunities surrounding transportation systems advances could be identified.

Bringing together advisory groups, representatives of various State and local transportation system operators, scientist and experts to identify transportation innovations, technology and productivity problems which they believe are essential to solve; provide support to the Secretary analyzing, developing and monitoring implementing policy.

Secondly, to create a new DOT R&D organization structure and management review process.

Within this recommendation we suggest that there be created within the Office of the Secretary a transportation technology, innovation and productivity entity.

Within this organization, reorganize the research and development activities currently housed within the Research and Special Programs Administration and establish a new policy-making role with funding capability to support Secretary studies.

Within this recommendation the Transportation Systems Center would become an integrator of external resources, the university and government and industrial for identifying and accomplishing basic technological initiatives in the transportation field.

Congressman Glickman questioned Charles Swinburn about suggested organizational and operational changes within DOT recommended by the President's Private Sector Survey on Cost Control:

Mr. SWINBURN. The private sector survey's recommendations, Mr. Chairman, were primarily threefold. First, they recommended there be within the Office of the Secretary a more centralized policy focus on R&D around the Department. Second, they recommended a structure within the Office of the Secretary to accomplish that end. And third, they recommended a greater involvement in determining the direction of the R&D programs within the Department by the private sector.

Those recommendations are presently before the Secretary, as are all of the recommendations made by the private sector survey team, which go well beyond R&D. She will, I think this week, be responding to the White House with her thoughts on the matter.

I can say that the recommendation that there be more policy oversight within the office of the Secretary of the Department's R&D is looked upon favorably, not just by the Secretary but by those of us who advise her and by the modal administrations. She is probably going to move to put in place a structure within the office of the Secretary to accomplish that.

The alternatives she is evaluating range from something that might be called a "Science advisor," if you will, an expert person with a small staff, to a more elaborate structure of the type recommended by the private sector survey. I think we probably will try to stay away from

the elaborate structures, feeling that th decentralization of our Department has worked fairly well in the past and we should try to avoid laying in a new layer of bureaucracy between the Secretary and the users of the products of the administration's R&D funds.

We are also very sympathetic to the third recommendation, that we should involve more of the private sector in the Department's decision—making processes. I should say it is not just private but the other public sector bodies, the States. I think FHWA has been doing a lot of that in the last couple of years under Administrator Barnhart and will do more. We are looking at the specific recommendations that were made on how we do that procedurally and have not yet made a decision.

Thomas B. Deen commented on management turnover:

If there was one single thing that I would point out as far as institutional problems in research it is turnover of management in this industry. Both at the Federal and the State levels, there is an enormous level of turnover at the top of these major large public sector entities that construct, maintain and operate the nation's highway system. I don't know that anything can be done about that, it is simply an observation. But it is difficult when you are talking about managing something that is intrinsically long-range to manage effectively when you have a large turnover. AASHTO says there are 20 new state chief administrative offcers, as they call them, and tops of state departments of transportation in the last 18 months. It is difficult to manage long-term activities with that turnover. The same thing happens at the Federal level, by the way.

Thomas D. Larson commented on problems of management of research:

Management of research has been touched on, and I couldn't stress too strongly the faults and foibles of management since I am a manager myself, and I can tell you for sure that it was two years before I could ask questions about research in my agency. Looking at DOT, the average tenure is two years, so any responsible secretary will never get to R&D simply because operational problems will subsume him for two years.

A researcher subject doesn't always get to the top of the deck even when it has enormous implications. The operating people have budgets of perhaps $1 billion to $2 billion and a research program, even if it solves a million dollars might be relatively small.

So I think research has suffered because we have not had continuity of management and management that was attuned to technological advance. And the value of innovations. Our managers are not attuned to that kind of thinking.

Mr. GLICKMAN. What about management in the road building industry?

Mr. LARSON. That is basically private sector management and they have not had as we heard discussed around here, a strong profit motive for doing things that are to great advantage.

Congressman Glickman questioned Mr. Swinburn about management turnover at the Department of Transportation:

Mr. GLICKMAN. Several witnesses have stressed that a major impediment to effective research, especially long-term research, is top

policy management, both in appointed and elected officials. I think probably the record would show there have been a number of DOT Secretaries, Deputy Secretaries, FHWA Administrators, Assistant Secretaries for Policy, since DOT was established in 1967.

How do we have any long-term policy on research if the average tenure is very short, at least anyone in a position to make a decision?

Mr. SWINBURN. We would like to give you a twofold answer to that, sir. It is correct that there has been a lot of turnover in the Department. I have been there for 12 years and I'm working for my seventh Secretary at this point.

It is that kind of turnover that I think leads to positive consideration by all of us of creating an institutional focus within the office of the Secretary of the type recommended by the private sector survey.

Again, we think the focus should be there, and I am sure the Secretary will create some organization to respond to that. I doubt if it will be as complex an organization as has been recommended by the private sector survey.

I should note that yes, there has been a lot of turnover at the highest political levels, again, the Secretary's deputies.

Howard Dugoff indicated that in addition to the short-term outlook in the executive branch, there is significant short-term pressures from Congress:

Without by any means attempting to take issue with your implied suggestion that the extent and nature of turnover at high echelons in the Executive Branch cuts against the likelihood of a long-term perspective in R&D planning, which I agree is a generic problem in the Federal Government, I would also like to elaborate on a point that Mr. Lamm made earlier, to the effect that as much as it is the tendency of Executive Branch management to exert pressure towards a short-term perspective, I believe the Congress, in general, or at least that community of Congress that has been most influential in our Department's appropriations process, has exerted the same type and I think a more influential force in that direction. So to the extent that this Committee could constitute a countervailing force in the interest of a longer-term perspective, you would be serving our programs very well, indeed.

Congressman Gore questioned C. V. Wootan and Della M. Ray on training future researchers and research managers:

Mr. GORE. Are engineering colleges and graduate schools adequately educating and training future researchers and research managers in this area of highway transportation and infrastructure? Do you think they're doing an adequate job now and, if not, what needs to be done to improve it?

Dr. WOOTAN. I think we have a real problem, which we have all experienced—we have, and I know Penn State has, and all the other major engineering universities—in attracting and supporting graduate students. We have had a problem of just getting the numbers of graduate students that we should be getting and turning out. I think the universities face a very trying time in the future. We are not educating and training people who can teach in the universities in ten or fifteen years from now. We're going to hit a big gap in that area because we do not have the graduate programs.

In order to sustain graduate programs, we need a viable research program. The two must go hand in hand. You can't have an effective

graduate program without having a research program. Now, that can be funded from many different sources, but you do have to have a research program to be able to support and train you. PhD. level particularly, engineering graduates. I think we are woefully behind in that area now and face some serious consequences in higher education ten or fifteen years down the pike.

Dr. Roy. I think that very much follows through. Our university is certainly the case. The students at the bachelor's level, if they can land a good job rather quickly, they are more likely to jump to it if they do not see any immediate possibility of a research establishment into which they can productively go.

Now, there have been one or two examples counter to this in the cement and concrete application in nuclear waste. We have been able to do a little bit because we got Department of Energy fellowships for some graduate students at the master's level, and they would sense that, because someone would give them a fellowship, that there probably would be a job at the end of that if somebody really wants their increased skills at the end of that period. So this sort of thing can be encouraging. But to continue on to get competent people in the future as teachers, as well, is an enormous problem.

F. Impediments to Government and Private Sector Research Cooperation

David R. Belle Isle summarized the findings of the Transportation Task Force of the President's Private Sector Survey on Cost Control regarding joint public and private research efforts:

Our final recommendation is to posture and encourage potential joint efforts in transportation research and development.

With private sector commitment and a sense that there is a market potential for a product, they would be willing to carry some of the burden of R&D funding and remove some of the burden on the taxpayers.

Douglas Pewitt commented on appropriate public and private sector responsibilities in support of research:

The third and most controversial criterion of our science policy is the appropriateness of the Federal role. The controversy arises over interpretation of what is or is not appropriate. Our aim is to distinguish clearly between Federal and private sector responsibilities. This aspect of our policy is not born of ideology but practicality. The private sector which operates in the marketplace is far more successful than the government in undertaking commercially-oriented technology. So we have worked to shift the Federal role in civilian research and development away from demostrations of technology. We are moving the government toward a more appropriate role in basic research and noncommercial development areas where the government is clearly responsible.

It is the administration's view that the Federal Government should fund R&D to meet specific government needs, where the principal user is the government itself—for instance, to support national defense.

Also to support national needs, where the Federal Government shares responsibility with the activities of a sort that private firms cannot realize a sufficient return to warrant individual investment.

The administration will support research activities that result in new knowledge from which commercial technology may ultimately be derived. However, it is uniquely industry's role to translate this knowledge into commercial processes and products. In addition, the Federal Government has the responsibility for ensuring that it does not stifle R&D activities in the private sector through poorly designed regulations and tax policies.

Congressman McCandless asked Thomas Deen about impediments to research in paving materials:

Mr. DEEN. The Portland Cement Association, which I think is what you are referring to, does have a fairly extensive laboratory and research program.

Representatives of that group tell me the amount of R&D they are doing in product improvement has substantially declined over the past 20 years and it is still declining. There is no incentive for management to spend money in product improvement because for a variety of reasons, one of them being that our method of procurement. We specify things and the opportunity for coming up with a better or improved product with long-term durability is one that the payoff would be small under those conditions. They don't see the incentive for doing that.

Dr. Belle Isle may want to comment on this, but I have met the Director of Research for his company, Martin Marietta; they are a company with a lot of areas in research, and I asked what research was done in the concrete area because they happen to produce a lot of Portland Cement, and he said "We don't do any research in Portland Cement."

I said "Why not?" He says "There is no incentive to do it because it is a situation in which the competition comes by providing it at the lowest possible price; it is a bid against specifications for the lowest price, and the low bidder gets it."

So there is not the incentive for the private sector in some industries to do that research.

Mr. MCCANDLESS. That is a part of the design requirement, in other words, the Department of Transportation, or whoever puts out the design specifications for a given length of interstate highway, saying it shall provide a certain this and that and so on, and they are holding the trump card when it comes to the quality and life expectancy of the materials.

All they are doing is saying they want another five-sack mix or whatever the terminology is, so everybody provides the five-sack mix rather than say "If you can provide us with a material that will withstand salt for a period of time," and et cetera, et cetera, "that that will be a consideration in the ultimate award of the bid," or whatever.

It would appear to me that those would be incentives for research?

Mr. DEEN. Incentives could be altered and that is something too that needs to be looked at. In the situation you just described, the DOT for the state of whatever, who put out the specifications, would have to have the research capability to examine that product. Simply accepting the claim of the bidder that he can produce this stuff that is twice as strong is not adequate. You get those claims all the time. You have to have a research program to evaluate those claims.

We are not in a position to do that effectively now in some cases. Certainly not enough to make this produce improvement you describe.

I am not saying that there are no advances. As a matter of fact, I am told by concrete experts that all the technical papers now in the professional societies for improvements in concrete are coming from outside the U.S., they are spending more, particularly in Europe, and they are advancing, polymers in concrete is another one—air entrailment goes back before that—use of gels in concrete that provide certain properties that make it stronger than the present concrete, and those developments are coming from outside this country primarily.

Mr. McCandless. Are we in need of research in other commodities in this interstate scenario beyond that of concrete? Is that the weak link?

Mr. Deen. No. I wouldn't single out that. I think all the basic materials, asphalt I singled out, and I would urge you to look at that. We think asphalt, perhaps given the fact we are moving into a more maintenance and rehab phase rather than new construction, that indeed asphalt and materials of asphalt and methods and processing and training, that whole smear of activities is an area that is at least as in need as much as Portland Cement.

Materials are not singled out either. There are a couple others we mentioned.

Mr. McCandless. The Asphalt Association of California or the United States, or whatever their trade organization is called, they are not able to offer what it is we want in the way of a quality product?

Mr. Deen. Those institutions in both cases have declined their activities substantially as this idea that you are competing has declined, and indeed the whole upheaval and economics of the oil industry where we get the asphalt has influenced this.

Asphalt is a big thing to the highway industry; 18 to 20 percent of all the money we spend is spent for asphalt in place. It is only four percent of the revenues of the oil industry, though. It is low priority. If any of us were management in that industry, we would not give it much priority. They are probably doing what they are doing as a service to government, but it is not going to be something that will inspire them to spend a lot of extra money in product improvement.

Mr. McCandless. I would only comment that my experience with asphalt is that the oil companies only supply the basic ingredient in tank carloads and that the batch plant would be looking for ingredients beyond that of simply the oil product in their raw materials that they use.

Mr. Deen. I think you have hit on another aspect of this. There is no single point you can point to and say that is where it ought to be done. You have the source of the basic crude stocks, you have the refining process, you have the batch plants and the aggregates and additives and asphalt materials mixed in, you have the people in the departments of transportation specifying the mix designs, and you have the people in the construction process, and you got the researchers.

They are all tied together and when you get a group of these people in the room to see what is causing problems in asphalt, there is a tendency for all fingers to be pointing in different directions. There is no single place where any substantial effort is made where they are working on a sustained basis. It is a fragmented process intrinsically.

Congressman Durbin questioned Mr. Deen and Dr. Belle Isle on impediments to providing an improved product:

Mr. DURBIN. You seem to suggest in your earlier testimony with my colleague, Mr. McCandless, that we are self defeating in our procurement policy in that we set the lowest common denominator for uniformity of bid and the producers are not encouraged to experiment and try to provide products beyond those specifications in terms of quality.

And you say we as a government don't have the research facilities to test new products and find out whether or not they can meet the standards that the producer suggests. How do you balance the fact that in government we want to make certain we get our dollars' worth and not invest in some product with wild claims and something that won't do the job and still encourage this basic research into new product lines?

Mr. DEEN. The question you ask about how to alter our system of procurement in a way that will inspire or provide some motivation is one we are asking ourselves, and I think it is indeed one that Dr. Belle Isle may wish to speak to. He was speaking to that problem in a suggestion of what he called research partnerships to try to encourage this. It is an innovative idea that we are looking at carefully that may be one of the things we should try.

Mr. DURBIN. If you had such a partnership, how would government respond in procurement specifications to be sure that we still do get a good product even if it is from a partnership as opposed to an individual company?

Dr. BELLE ISLE. Mr. Deen mentioned that the Department of Transportation, if they would do the basic research to identify specifications to meet a need, then be able to review various product proposals that are deemed by the producer to meet the criteria, that they could fulfill their end of the bargain.

That is not that costly in terms of total effort. The research most costly is the nature of looking at various materials, bringing it from a product identification, product test and finally to a prototype where you apply it; that sequence of events for any one corporation is just too costly without consortiums of various companies working together to meet the specifications that the Department could develop and have the capability to review.

What we are saying here is that given the profit motives of different companies, they would tend not to work in a joint venture with potential competitors to jointly come up with a material that might meet the specs. So, therefore, we get the fragmentation.

I would like to suggest, however, that it would be possible if the Department of Transportation could come up with specifications around key materials and then enable the producers to see the long-term market and demand for this product, that there is going to be enough consumption of the product for everybody to get a piece of the action, nobody could do it anyway. There is no one producer that could handle the volume required.

Mr. DURBIN. Sounds like a patent policy you are talking about where you have exclusive rights for a lengthy period of time.

Dr. BELLE ISLE. That is right. Imagine a research joint partnership in which the licensing of the patent would be shared by this consortium. There is an example of this in the computer industry. What will hap-

pen is that they will then race to the marketplace and each competing with the other ones, that technology is developed, and go through the development steps. All we are saying is that the same has to occur here where the technology and the basic material can be done through joint venture, and then let them compete in application of that material in reconstruction and repair.

Congressman Glickman asked Mr. J. Young about the structure of the U.S. cement industry:

Mr. YOUNG. As I indicated earlier, we are talking about 45 separate corporate entities who produce the product. The largest cement producer (Lone Star) accounts today for about 11 percent of the total capacity.

Mr. GLICKMAN. Has the industry as a whole made any money in the last few years?

Mr. YOUNG. I would say, if you took the total financial results of the industry in 1981 and 1982, you would see a loss.

Mr. GLICKMAN. You have characterized both economic deterrents to more cement research and structural deterrents. If the current recovery continues and construction activity expands, will more research investments necessarily follow without significant structural changes?

Mr. YOUNG. I would suspect that if there is a general recovery in our industry there would be more willingness to fund greater research on an association basis. The factors I alluded to earlier, that the innovator gets very little of the benefit of the innovation, it slows down individual companies from doing research because they can't get much selfish benefit. However, when they join together in an association, then you can take the broader view because, as we make our product more competitive, it should make deeper inroads as a construction materials over time.

Mr. GLICKMAN. Would some kind of life cycle costing for highway and bridge projects—as we heard last week, and I think maybe Mr. Young referred to indirectly today—help remove the low-first-cost deterrent to research that you mentioned?

Mr. YOUNG. I believe so, very significantly.

Mr. GLICKMAN. What do you think would have to be done to get states and local units of government to abide by that kind of change? Do you think you need to change state laws, or do they have that discretion now?

Mr. YOUNG. I think we would have to take what I would consider a more realistic view at the design stage. For instance, as I mentioned, our interstate program was designed for a 20-year life and it was designed with lower weights in mind than it is experiencing. And it was designed for lower traffic than it is experiencing.

Now, all this translates into a lower first cost, but it is very expensive over time. There is no secret in laying a pavement that will last a long, long time if you design for it. In Europe they traditionally design their highways for a 40-year life, not a 20-year life, and they get it because they put the up-front money down that is necessary to get the quality pavement to last the desired period of time.

I find a parallel—not so much with the cement manufacturers—but I find a parallel between the relationship of the construction industry and government, as I do in the defense industry and gov-

ernment. Government, in fact, determines the quality of the product and design issues as well as research priorities much greater than almost any other kinds of industries that you see. Most industries, like the IBMs and 3Ms, they kind of determine it themselves based upon the use. Naturally, of course, state governments are composed of elected political officials who want to get reelected; therefore, they want to repair roads as quickly as they can and want to get concrete or asphalt laid, where appropriate, as quickly as they can. I would submit that usually the people in the construction business are not as likely as perhaps other segments of our society are in dealing with design phase issues because of the whole nature of the institutional process. That is probably the reason why the Federal Government ought to take some of its money from this giant highway tax increase and plug it into some of the longer-term issues, rather than just focus it on laying more concrete or asphalt down on the roads.

APPENDIX

(1) The Highway Infrastructure: System Status and Current Trends

STATUS OF THE HIGHWAY INFRASTRUCTURE

The U.S. Department of Transportation (DOT) estimates that nearly 10 percent of the Interstate Highway System (more than 4,000 miles) are in need of immediate or near-term resurfacing or replacement. Before 1995, an estimated 26,000 miles or 65 percent will need major resurfacing or repair work.[1] Others estimate that 8,000 miles of the interstate system and 13 percent of its bridges have exceeded their original design life and are in need of rebuilding, and another 2,000 miles of the interstate system deteriorate sufficiently each year to require some reconstruction.[2]

Beyond the interstate system, 50 percent of the entire Federal-aid primary highway system will reach the end of its design life during this decade, according to the DOT.[3] Regarding bridges, 37 percent of the total number are over 40 years old, and the useful life of a bridge is usually estimated to be 50 years. Of the total 564,499 urban and rural bridges in the United States, the Federal Highway Administration lists 132,154 as structurally deficient, another 121,042 as functionally obsolete.[4]

Reasons for this decline include pavements and structures aging beyond their original economic design lives; increased traffic and weight loadings beyond some design expectations; weather stress and related maintenance practices; less than optimal construction in some cases; and continuing deferrals of scheduled repair and rehabilitation outlays because of budget constraints at Federal, State, and local levels of government.

CHANGING EMPHASIS AND INCREASED FUNDING FOR TRANSPORTATION INFRASTRUCTURE GENERALLY

In previous decades, planning, design, and construction of new facilities enjoyed almost exclusive attention, and funding, under the Federal-aid highway program. This program is the almost exclusive source of funds for highway construction in the United States. With the Federal-Aid Highway Act of 1976 (P.L. 94–180), however, increased attention was focused on the need to preserve and rehabilitate existing highways and bridges. By 1982, 22 percent of Federal highway aid was directed at rehabilitation of older interstate system routes, and repair and placement of bridges.[5]

The Surface Transportation Assistance Act of 1982 (P.L. 97–424), continues the recent trend away from new construction and of increased emphasis on preservation of the transportation infrastructure. Beginning with FY '84, for example, not less than 40 percent of funds apportioned to each State for Federal-aid primary, secondary, and urban systems are to be spent on resurfacing, restoring, rehabilitating and reconstructing existing highways, absent any special exception.[6] In addition, funding is also provided for highway bridge replacement and rehabilitation, including bridges on public roads and other than those in a Federal-aid system.

The 1982 Act explicitly recognizes the importance of preserving and maintaining the highways and other transportation systems. Section 110(a), for example, shows the intent of Congress that Federal funds for resurfacing, restoring, rehabilitating work shall be expended in accordance with standards to preserve and extend the service life of the highways and enhance highway safety. The section goes on to direct the Secretary of Transportation to engage the National Academy of Sciences and others to conduct a study of the safety and cost-effectiveness of geometric design criteria of current highway construction and reconstruction standards, and of the minimum standards applied to resurfacing, restoration, and rehabilitation work, and to propose new standards for Congressional approval.

An additional example in the 1982 Act of increased Congressional interest in infrastructure preservation and maintenance includes a provision of incentives to States for the use of innovative technologies and products from recycled materials or asphalt additives to strengthen highway and bridge surfacing, resurfacing, or restoration materials. The Act also significantly increases funding for infrastructure repair and replacement, through increases in the Federal automotive fuel tax from 4 cents per gallon to 9 cents per gallon, by increases in excise taxes on truck tires and in use taxes on heavy trucks. According to DOT estimates, the additional revenues generated, approximately $5.5 billion, will meet about 90 percent of interstate system repair needs and 100 percent of estimated rehabilitation needs on deficient bridges.[7]

TRANSPORTATION INFRASTRUCTURE RESEARCH FUNDING AND TRENDS

Research and technological development have long been a part of the overall Federal-aid highway program, enjoying a continuing consensus that federally coordinated and funded research and development work is a desirable, perhaps essential, element of a national highway investment program sufficient to support long-term economic growth.

Under the 1982 Act, highway planning and research funds apportioned to the States would increase from $92 million in FY '82 to over $150 million in FY 83, with additional increases expected in subsequent years. The increases, as in the past, likely will be expended mostly on short-term research efforts, since the 1982 Act contains no significant redirection or focus for planning requirements or procedures. Additionally, State research programs, because of budget constraints and cutbacks, may not be able to accommodate efficiently the increases in planning and research fund apportionments made possible by the 1982 Act.

The recent trend of declining resources directly available to the DOT for research and development may be reversed in 1983. Total research and development obligations by the DOT are targeted at $393 million in FY 83, up from $309 million in FY 82. The President's budget for FY 84 estimates total obligations of $519 million for DOT research and development in FY 84. Of this total, however, just $49 million would be obligated for highway infrastructure research and related projects.

ORGANIZATION AND FOCUS OF CURRENT HIGHWAY INFRASTRUCTURE RESEARCH AND DEVELOPMENT PROGRAMS

Federally assisted highway R&D programs spent nearly $60 million in FY 1983. Currenty there are four major programs performing highway R&D. These are Highway Planning and Research (HP&R) program; the National Cooperative Highway Research Program (NCHRP); the Federal Highway Administration (FHWA) administrative contract program; and the FHWA staff research program.

The HP&R program is the cooperative Federal/State venture authorized by Section 307 of Title 23, U.S.C. The available HP&R funds are used by the States to Finance a two-part program: Part I, Planning, and Part II, Research. The share allocated to research range from 5 to 55 percent, with an average of approximately 20 percent. This year the States have programmed $31 million of the $151 million available in HP&R funds, for research activities. The FHWA provides technical guidance and coordination, and reviews and approves both the overall program and the individual study elements.

The NCHRP is a three-way contract between the American Association of State Highway and Transportation Officials (AASHTO), the FHWA, and the Transportation Research Board (TRB). Research activities are selected by a special committee of AASHTO, called the Select Committee on Research, and administered by the TRB, with approval by the State highway officials.

Under this program, 4½ percent of the HP&R funds are pooled by the States on a voluntary basis for research which responds to the collective needs of State highway agencies. The FHWA reviews contractor selection, reviews program content, and determines when completed work have fulfilled the technical requirements. Program selection and composition are the prerogative of AASHTO and the participating State highway agencies, through the Select Committee. For FY 1983, $6.8 million was available for this program.

The FHWA now conducts a major portion of its own research and development work by contract as authorized by Title 23. Funding for this activity comes from the Highway Trust Fund and is reviewed, authorized, and appropriated annually by the Congress. These funds are separate and apart from the HP&R funds and amounted to $21.5 million in FY 1983.

Finally, a staff research and development program is conducted by FHWA employees. While some of the staff R&D is devoted to continuing efforts in major problem areas, a significant portion is geared to quick-action response for immediate problems identified by the operating offices of FHWA.

Approximately 20 percent of total R&D employee time is spent conducting staff research. The remaining time is used to plan, administer, and monitor activities supported by Federal funds, including contract research, HP&R, and NCHRP.

Criticism of the current effort has focused on: a trend away from longer-term, basic research in the DOT to quicker-payoff, applied research projects; a trend toward increasing instability of the research funding; continued lack of emphasis on basic research; the need for better focusing of national priorities on research activities; and the lack of economic incentives for technological innovation and research productivity.

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[1] U.S. Department of Transportation: Fact Sheet, November 29, 1982.
[2] See, for example, B. S. Moskal, "American on the Road to Ruin?", Industry Week, March 7, 1983, p. 36.
[3] U.S. Department of Transportation: Fact Sheet, November 29, 1982.
[4] Highway Bridge Replacement and Rehabilitation Program, Fourth Annual Report of the Secretary of Transportation to the Congress of the United States, November 1983, pp. 35 and 36. (Senate Document No. 98–19.)
[5] U.S. Department of Transportation, Federal Highway Administration: Highway Statistics 1982, p. 52 and 53, Table F4A.
[6] Surface Transportation Assistance Act of 1982 (P.L. 97–424), Section 150(d).
[7] U.S. Department of Transportation: Fact Sheet, November 29, 1982.

(2) List of Witnesses

David R. Belle Isle, Ph.D., Project Director, Department of Transportation Task Force, President's Private Sector Survey on Cost Control
William S. Butcher, Ph.D., Director, Civil and Environmental Engineering Division, National Science Foundation
Thomas B. Deen, Executive Director, Transportation Research Board, National Academy of Sciences/National Research Council
Howard Dugoff, Administrator, Research and Special Programs Administration, U.S. Department of Transportation
Randall L. Erickson, Ph.D., Program Manager, 3M Company
Ralph E. Gomory, Ph.D., Vice President and Director of Research, IBM Corporation
Anthony R. Kelly, Ph.D., Vice Chancellor, University of Surrey, Surrey, England
John B. Kemp, Secretary, Kansas Department of Transportation, Topeka, Kansas
Lester P. Lamm, Deputy Administrator, Federal Highway Administration, U.S. Department of Transportation
Thomas D. Larson, Secretary, Pennsylvania Department of Transportation, Harrisburg, Pennsylvania
Pat McCue, on behalf of Paul N. Pappas, Secretary, Florida Department of Transportation, Tallahassee, Florida
John Mladinov, Deputy Commissioner, New York Department of Transportation, Albany, N.Y.
N. Douglas Pewitt, Ph.D., Assistant Director for General Sciences, Office of Science and Technology, Executive Office of the President
Della M. Roy, Ph.D., Professor of Materials Science, the Pennsylvania State University
Richard W. Smith, Ph.D., Director of Research and Development, National Asphalt Pavement Association
Charles Swinburn, Deputy Assistant Secretary for Policy and International Affairs, U.S. Department of Transportation
Gerald S. Triplett, President, The Asphalt Institute
Edwin Wood, Associate Administrator for Research, Development and Technology
C. V. Wootan, Ph.D., Director, Texas Transportation Institute, Texas A&M University
William J. Young, President, Portland Cement Association

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